Detection of ^{257}Rf with the SISAK On-Line Liquid Scintillation Detectors

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SISAK is a fast, on-line, continuous chemical-separation system. It was developed to investigate short-lived nuclei recoiling out of an irradiated target and transported in a gas jet. The system is based on small (0.3 mL volume) centrifuges with a continuous feed and output. See [1] and references therein for details.

During the last years, work has been performed to deploy SISAK in studies of the chemical properties of the transactinides ($Z \geq 104$). Due to low production rates (a few atoms per hour or less), $\alpha\alpha$-correlation detection is usually employed for unambiguous identification. The only suitable detection method found was liquid scintillation (LS) counting, due to the large liquid volumes involved (0.3-1.5 mL/s). Although LS counting has a high efficiency, this detection method has relatively poor energy resolution (~300 keV FWHM) and is sensitive to β particles and γ rays. This put very stringent demands on the separation system, because most of the contaminants are produced with much higher yield than the transactinide under study. Thus, decontamination factors of 1000 or even higher are necessary.

Our detection system uses pulse-shape discrimination to reduce the β background in the α spectra by a factor of 100-1000 in addition to the very efficient chemical separation in the centrifuges. However, several experiments have shown that the sensitivity still was insufficient for transactinide work. Therefore, an experiment in which the Berkeley Gas-filled Separator (BGS) was used as a preseparator was performed. In this experiment the SISAK detectors were employed without the chemical separation system to prove that our detectors and acquisition system could uniquely identify and detect transactinides.

The recoils exiting the BGS were transferred to a gasjet (1.8 bar He gas with KCl aerosols flowing at 1.0-1.2 L/m) by a recently constructed recoil transfer chamber (RTC) [2]. The transport time from the target to the SISAK-LS detector cells was measured as ~6 s for break-through and about 11 s for the main part of the reaction products.

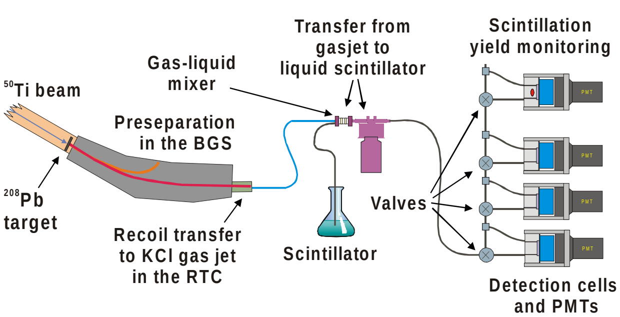

Figure 1. Setup used for SISAK detector test experiment.

A test of the SISAK detectors was performed with the setup shown in Fig. 1. The reaction ^{208}Pb(^{50}Ti,1n)^{257}Rf was used. The amount of ^{257}Rf entering the RTC chamber was measured with an array of Si-strip detectors. 6-7 ^{257}Rf-^{253}No $\alpha\alpha$-correlations per hour were detected. This corresponds to about 25 ^{257}Rf nuclei entering the RTC per hour.

In the first SISAK detection cell, 26 $\alpha\alpha$-correlations were detected during a total of 17 hours beam time, or about 1.5 correlations per hour. The detection system was run in mother-daughter mode: Any α-event with an energy between 8.3 and 10.5 MeV forced the cell to close, i.e., switch to daughter mode. The cell remained in daughter mode for four daughter (^{253}No) half lives (408 s). The measured correlation matrix is shown in Fig. 2. The results clearly show that the SISAK LS detection system is able to uniquely identify and detect nuclei at a rate of a few atoms per hour.

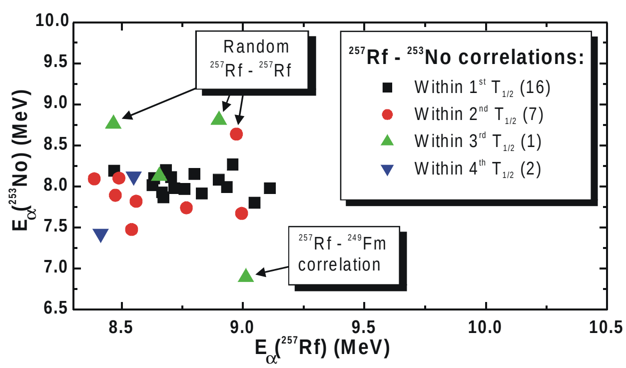

Figure 2. Measured $\alpha\alpha$-correlation matrix..

As the data analysis is not jet completed, the results reported are preliminary and only include data from the first of three detectors.

References

★ Univ. of Mainz, Univ. of Gothenburg and Univ. Of Oslo collaboration: J. Alstad, K. Eberhardt, M. Johansson, M. Mendel, A. Nähler, L.A. Omtvedt, G. Skarnemark, L. Stavsetra, N. Wiehl, J.P. Omtvedt, N. Trautmann,

✤ C.M. Folden, T. Ginter, K.E. Gregorich, U.W. Kirbach, D.M. Lee, V. Ninov, J.B. Patin, R. Sudowe, P.A. Wilk, P.M. Zielinski, H. Nitsche, D.C. Hoffman.

1 J.P. Omtvedt et al., J. Alloys and Compounds, **271**, 303, (1998).

2 U. Kirbach et al.:*"The Recoil product Transfer Chamber (RTC): A new interface..."*, LBNL NSD Annual report 1999.